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Nutritional Content of Bone Flour Made from Plecos Fish *Pterygoplichthys pardalis* from the Ciliwung River, Indonesia

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Abstract. *Pterygoplichthys pardalis* bones that are thrown into the river is one source of pollutants in the Ciliwung River. *P. pardalis* bones have a high calcium content, they can be used as an alternative raw material for flour. The purpose of this study was to analyze the nutritional content of *P. pardalis* bone flour from the Ciliwung River. The research method used was a proximate analysis consisting of moisture, ash, fat, protein, and carbohydrates content analyses. Proximate analysis results showed that the *P. pardalis* bone plus head flour contained 3% moisture, 35% ash, 34% protein, 23% fat, and 5% carbohydrate. *P. pardalis* body bone flour contained 4% water, 37% ash, 37% protein, 19% fat, and 3% carbohydrate. Based on the proximate analysis results, *P. pardalis* bone flours did not met the national standard of SNI 2013 fish flour for quality I, II, and III. Until now, there has been no research that explain the nutritional content of bone flour of *P. pardalis* from Ciliwung River. This research provides information on the nutritional content of P. *pardalis* flour. Data obtained from the results of this study can be the basis for consideration in utilizing and processing P.*pardalis* from the Jakarta Ciliwung River.

Key words: Ciliwung River, fish bone flour, nutrient content, proximate, *Pterygoplichthys pardalis*

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INTRODUCTION

The community caught *Pterygoplichthys pardalis* for flesh, while the rest of the body was thrown into the river. Other P. *pardalis* body parts such as bones, head and tail are thrown into the river so that they become a source of pollution in the Jakarta Ciliwung River. Fish bones are classified as solid waste and fish processing waste (non-edible portion). Fish bones have the most calcium content among fish body parts, it also contains phosphorus and carbonate (Sinaga et al. 2018). P.*pardalis* bone meal contains 21-25% calcium, and 10-11% phosphorus (Bechtel et al. 2019). The calcium phosphate complex of fish bones can be absorbed well by the body in around 60-70% (Edam, 2016). High calcium content in fish bones makes it becomes an alternative source of calcium. Calcium ions (Ca^{2+}) Eare important for the development of human bones and teeth (Hemung, 2013). Fish bones can be processed into various food products, through processing into fish bone flour.

Fish bone meal is a product of fish waste processing which is produced in the form of flour (Bunta et al. 2013). Fish bone flour contains high calcium which is 12.8 mg/100 g in ariid catfish (*manyung*) and 15.2 mg/100 g in chub mackerel fish (Mahmudah, 2013). Bone flour is used as a raw material for making feed and various processed foods because it has mineral content (calcium and phosphorus) and a little amino acid (Murniyati et al., 2014). Production of animal-based flour, especially bone, is still rare in Indonesia. Bone flour has great potential as a processed food raw material because of its calcium content.

One type of fish flesh that is used as an alternative source of protein and raw material for processed food products is P. *pardalis* originating from the Ciliwung River. The flesh is used as raw material for various food products such as siomay, batagor, fleshballs and otak-otak (Munandar & Eurika, 2016). People who catch *P. pardalis* generally only take the fish's flesh and eggs. *P. pardalis* flesh is used as a mixture of crackers and the eggs are used as fishing bait. While, other parts that are not used (internal organs, skin, head, and tail) are discharged into the Ciliwung River. The remaining body parts of *P. pardalis* will become organic wastes which can cause pollution in the Ciliwung River. This is because fish bones are hard components that take a long time to break down (Fitri et al., 2016). The aims of this study were to analyze the nutritional content of bone flour from *P. pardalis* of Ciliwung River. The results are expected to be a source of information for the utilization of fish bone flour into processed food products.

METHODS

The research activities consisted of three main activities which were sampling, flour making, and nutritional content analysis of fish bone flour. The P.

pardalis sampling activity was carried out in the Ciliwung River Watershed, Jln. Inspeksi Ciliwung Letjen MT. Haryono Gg Ciliwung, Cawang, Central Jakarta. *P. pardalis* were collected, weighed, and separated between their flesh and bones. The head and tail bones were held together while the body bones were separated. The remaining flesh was cleaned from the bones, then lime juice was given to remove the fishy odor. The bone was then put into plastic and stored in the freezer.

The making of P.*pardalis* bone flour

Flour making was done at IPB Seafast, Bogor. The process of making the flour begins with soaking the frozen bones in water for a few moments, then dried in the sun for 2 days. The bones were then reduced in size with multi mill machine to speed up the drying process. The bones were dried with a cabinet dryer (oven cabinet) with a temperature of 60℃ for 6 hours. *P. pardalis* bones were then smoothed with a 40 mesh dismill. The final result obtained was bone flour with fineness of 40 mesh.

Nutritional content analysis of fish bone flour

Nutrient content analysis of *P. pardalis* bone flour was carried out with a proximate test which included water, ash, fat, protein, and carbohydrate contents. Activities carried out at the National Nuclear Technology Agency (*Badan Teknologi Nuklir Nasional* [BATAN]).

Moisture and ash content analysis (AOAC, 2005)

The crucible was dried in the oven at 105 ℃ for 24 hours. Then, it was put into the desiccator for 15 minutes. The flour sample was weighed as much as 0.2 g, then the sample was put into a cup. The filled cup was dried in an oven at 105 ℃ for 24 hours and then put in a furnace for 5 hours. The crucible then was removed from the furnace and put in a desiccator for 15 minutes after it was weighed. Calculation of water and ash content was determined by the formula:

Moisture content (%) = $\frac{\text{Wet weight} - \text{Weight after drying}}{\text{Wet weight}} \times 100\%$

Ash content (%) = $\frac{Ash\ weight\ (g)}{Sample\ weight\ (g)} \times 100\%$

Fat content analysis (AOAC, 2005)

Filter paper was weighed, then a sample of 0.2 g was spread on the filter paper, after which the filter paper was rolled up and put into a Soxhlet extractor. Filter paper containing the sample was extracted for 6 hours with 300 ml petroleum ether. The filtered paper that had been extracted was then dried in an oven at 100℃ for 1 hour. The dried sample was then chilled in a desiccator for 15 minutes and weighed. Calculation of fat content was determined by the formula:

Fat Content (%) = $\frac{\text{Fat weight (g)}}{\text{Sample weight (g)}} \times 100\%$

Protein Content Analysis (AOAC, 2005)

Protein analysis was done using the Micro-Kjeldahl method which consisted of destruction, distillation, and titration. The destruction stage was carried out by inserting 1 g of flour sample, 1 tablespoon of selenium mixture, and 5 ml of concentrated H_2SO_4 into a 100 ml Kjeldahl flask. The Kjeldahl flask was heated for 15 minutes until the solution had a clear green color. Then the distillation was performed, the Kjeldahl flask was left to cool slightly then 10 ml of distilled water was added and transferred to the distillation flask and then added 20 ml of 40% NaOH. The solution was distilled for 15 minutes, then the distillate was collected in an erlenmeyer flask that had been filled with 15 ml HCl 0.1 N and 3 drops of red metal pointer. The final process was titration, the ammonia that had been distilled was accommodated with 0.1 N HCl solution. HCl excess was titrated with 0.1 N NaOH solution to the end point. Calculation of protein content was determined by the formula:

Protein content (%) = $\frac{(V_a - V_b)HCl \times NHCl \times 14.007 \times 6.25}{W \times 1000} \times 100\%$

Information: V_a = HCl sample titration (ml); N = HCl Normality; V_b = HCl blank titration (ml); W= Weight (g)

Carbohydrate content analysis (AOAC, 2005)

P. pardalis bone flour carbohydrate content analysis was using the *by different* method based on the reduction factor. Proximate analysis results obtained (contents of protein, moisture, ash, & fat) determine the amount of carbohydrate content. Carbohydrate content calculation was done based on the formula:

Carbohydrate Content (%) = 100% - % (protein + fat + ash + moisture)

Data Analysis

P. *pardalis* bone flour proximate analysis produced data that was processed manually using Microsoft Excel. The data were generated in the form of percentage of nutritional content.

RESULTS AND DISCUSSION

Fish Bone Meal

Flour made from a combination of head and tail bone of P.*pardalis* is more concentrated and has a stronger aroma than the body bone flour (Figure 1).

P. *pardalis* bone flours are coarse with 40 mesh fineness, brownish, and fishy. The low fineness is due to obstacles when grinding. The obstacle faced was the fish bone stuck to the multimill tool, thus inhibiting the grinding process. Physical characteristics of P.*pardalis* bone meal produced do not reach the standard of fish meal according to SNI 2013. Fish meal must have a coarse with 80-95 mesh fineness (BSN, 2013). Apart from not reaching SNI standards, the physical characteristics of P.*pardalis* bone meal did not meet the standards as high quality fish meal. According to Orlan et al., (2019), the characteristic of high-quality fish meal is including texture with fine grains, uniform, free from the rest of the bones, the eyes of fish and foreign objects, clean bright colors, and the fishy fish's distinctive odor.

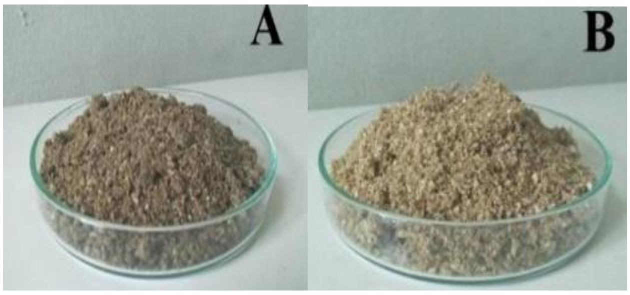

Figure 1. Flour made from Pterygoplichthys pardalis bone. **Note**: (A) Head plus tail bone flour, (B) Body bone flour.

Moisture Content

Moisture content is an important factor that determines the quality of food ingredients, because water affects the appearance, texture, and taste (Gumolung & Naomi, 2018). Based on (Figure 2), the moisture content of TTKE and TTBd is lower than SNI (BSN, 2013). According to Hemung (2013), the low moisture content of *Pterygoplichthys pardalis* bone flour is caused by the water molecules in the bone that are not included in bone tissue, but are weakly bound to the bone surface. Therefore, almost all water molecules can be released during the flour drying process. Moisture content determines the quality of a food (Öztürk et al., 2019). The lower the moisture content, the better the quality of food because inhibits microbial growth, as well as oxidative and enzymatic reactions thereby extending shelf life (Bourdoux et al., 2016). The difference in water content of a food varies based on the type of material, variations, and storage conditions (Amitha et al., 2019).

Ash Content

P. pardalis bone flour did not meet the SNI 2013 standard because it had high ash content (Figure 3). A high ash content in the *P. pardalis* bones is due to the minerals as the main components. Bone contains living cells and intracellular matrix in the form of mineral salts (Putranto et al., 2015). Mineral salt is a component that consists of calcium phosphate as much as 80% and the rest consists of calcium carbonate and magnesium phosphate (Darmawangsyah et al., 2016), thus they causes *P. pardalis* bone flour ash levels to increase.

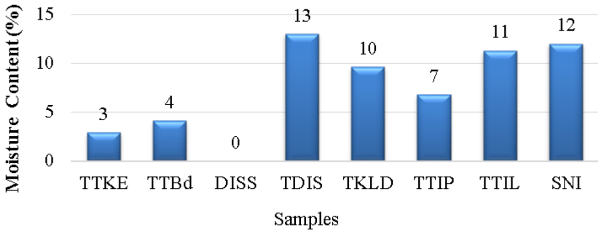

Figure 2. Comparison of fish flour's moisture contents. **Note:** TTKE: Head+Tail Bone Flour; TTBd: Body Bone Flour; DISS: *Pterygoplichthys pardalis* Flesh (Elfidasari *et al*. 2019); TDIS: Plecos Catfish Flesh Flour (Hutasoit, 2014); TKLD: African Sharptooth Catfish Head Bone Flour (Widiyanto, 2018); TTIP: Iridescent Shark Fish Bone Flour (Nur *et al*. 2018); TTIL: Catfish Bone Flour (Witdiah, 2013); SNI: Grade I Fish Flour (SNI, 2013)

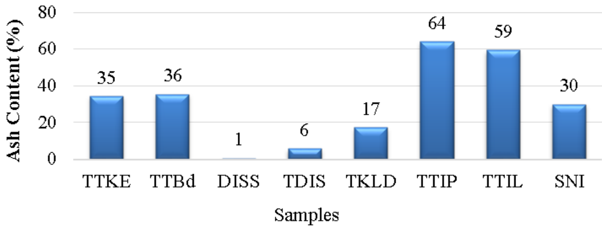

Figure 3. Comparison of fish flours' ash content. **Note**: TTKE: Head+Tail Bone Flour; TTBd: Body Bone Flour; DISS: *Pterygoplichthys pardalis* Flesh (Elfidasari *et al*. 2019); TDIS: Plecos Catfish Flesh Flour (Hutasoit, 2014); TKLD: African Sharptooth Catfish Head Bone Flour (Widiyanto, 2018); TTIP: Iridescent Shark Fish Bone Flour (Nur *et al*. 2018); TTIL: Catfish Bone Flour (Witdiah, 2013); SNI: Grade I Fish Flour (SNI 2013)

Fat Content

P. *pardalis* bone meal contains high levels of fat. Based on (Figure 4) TTKE and TTBd P.*pardalis* fish bone meal exceed the maximum limit of SNI 2013. High fat content causes flour to have fish taste and the occurrence of oxidative rancidity due to fat oxidation (Husna et al., 2020). Fat oxidation reduces food quality including causing bad taste and odor, shortening the shelf life, reducing nutritional values, and possibly harmful to health (Secci & Parisi, 2016). Fat is found in the bone matrix, especially the main bone of fish, which consists of many bone joints. The main bone fat of fish cannot be released easily because it is composed of complex bonds and is difficult to remove simply by immersing the bone in an alkaline solution (Hemung, 2013).

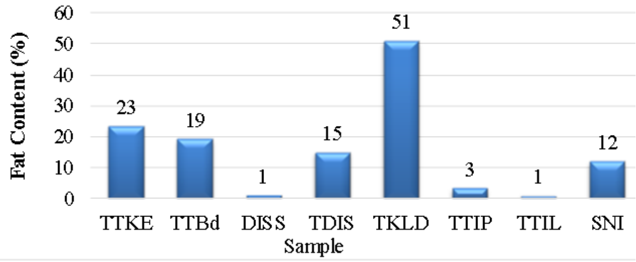

Figure 4. Comparison of fish flours' fat content. **Note:** TTKE: Head+Tail Bone Flour; TTBd: Body Bone Flour; DISS: *Pterygoplichthys pardalis* Flesh (Elfidasari *et al*. 2019); TDIS: Plecos Catfish Flesh Flour (Hutasoit, 2014); TKLD: African Sharptooth Catfish Head Bone Flour (Widiyanto, 2018); TTIP: Iridescent Shark Fish Bone Flour (Nur *et al*. 2018); TTIL: Catfish Bone Flour (Witdiah, 2013); SNI: Grade I Fish Flour (SNI, 2013)

Protein Content

Most of the protein in fish consists of complete amino acids including lysine, tryptophan, histidine, phenyalanin, leucine, isoleucine, threonine, methionin-cysteine, and valine (Cherlin et al., 2017). According to Amitha et al., (2019), fish bone powder contains high protein. P. *pardalis* bone flour contains higher protein than raw Tuna frame is reported to have 29% (Abbey et al., 2017). Based on the results of the proximate analysis P. *pardalis* bone meal did not reach the minimum limit of SNI 2013 (Figure 5). The low protein content of P. *pardalis* bone flour is caused by the oven-drying process used. The drying process causes denaturation of proteins. The process of protein denaturation is caused by several factors including high and low temperature, high pressure, ultrasound, irradiation with high doses (including microwaves), organic solvents, certain types of salts, detergents, and chaotropic agents (Movahedi et al., 2016).

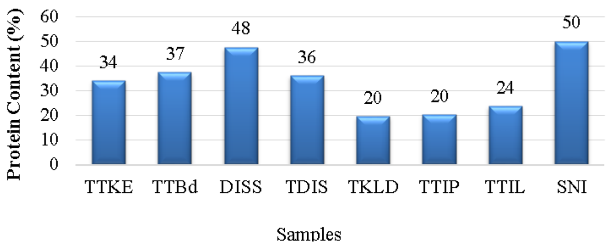

Figure 5. Comparison of fish flours' protein content. **Note:** TTKE: Head+Tail Bone Flour; TTBd: Body Bone Flour; DISS: *Pterygoplichthys pardalis* Flesh (Elfidasari *et al*. 2019); TDIS: Plecos Catfish Flesh Flour (Hutasoit, 2014); TKLD: African Sharptooth Catfish Head Bone Flour (Widiyanto, 2018); TTIP: Iridescent Shark Fish Bone Flour (Nur *et al*. 2018); TTIL: Catfish Bone Flour (Witdiah, 2013); SNI: Grade I Fish Flour (SNI, 2013)

Carbohydrate Content

Carbohydrate contents were determined with *by different* method. Based on the results of the proximate analysis P. *pardalis* bone meal has a low carbohydrate content (Figure 6). The low level content of carbohydrate is caused by the heating process with high temperatures, resulting damage to some carbohydrate molecules (Martunis, 2012). Starch is a major component of carbohydrates. Besides starch, fiber is also contained in carbohydrates (Mahmud et al., 2019). Increased temperature will increase the speed of hydrolysis of starch resulting in its breakdown into simple compounds such as glucose, maltose, and dextrin (Erni et al., 2018). Carbohydrate levels in fish are very low because of the low digestibility and carbohydrates are used as the main source of energy. This causes the level of carbohydrates stored in the body of the fish to be very low or almost zero except in the liver and muscle glycogen (Syahril et al., 2016).

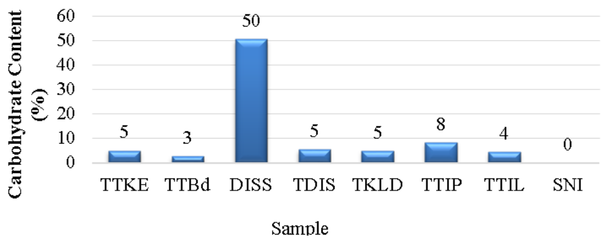

Figure 6. Comparison of fish flours' carbohydrate levels. **Note:** TTKE: Head+Tail Bone Flour; TTBd: Body Bone Flour; DISS: *Pterygoplichthys pardalis* Flesh (Elfidasari *et al*. 2019); TDIS: Plecos Catfish Flesh Flour (Hutasoit, 2014); TKLD: African Sharptooth Catfish Head Bone Flour (Widiyanto, 2018); TTIP: Iridescent Shark Fish Bone Flour (Nur *et al*. 2018); TTIL: Catfish Bone Flour (Witdiah, 2013); SNI: Grade I Fish Flour (SNI, 2013)

This research was conducted to analyze the nutritional content of P. *pardalis* fish bone meal caught in the Ciliwung River Jakarta. Analysis of the nutritional content of P. *pardalis* bone flour from the Ciliwung River was only carried out in this study. There is no research data that discusses the potential possessed by P. *pardalis* bones as an alternative raw material for flour. The results of this study indicate that the nutritional content of P. *pardalis* bone meal does not meet the SNI 2013. The ash and fat content of P. *pardalis* bone meal exceeds the maximum limit and the protein content does not reach the SNI minimum limit. Moisture content shows very good results because it is below the maximum limit of SNI. The low nutritional content of P. *pardalis* bone meal is caused by using bone as the raw material. Bones only contain high levels of minerals, so the content of other nutrients is very low.

This study provides nutritional information contained in P.*pardalis* bones which are processed into fish meal. So far P.*pardalis* is considered unable to be used as food raw material. This research is the basis of information to utilize P.*pardalis* as an alternative raw material for fish meal. Utilization of P.*pardalis* bones can reduce the impact of Ciliwung river pollution. P.*pardalis* bones can also be processed into various other useful products for the community. Further research is needed to determine how to process and utilize P.*pardalis* bones.

CONCLUSION

Based on this study, it can be concluded that the head plus tail bone flour of *P. pardalis* has 3% moisture content, 35% ash, 34% protein, 23% fat, and 5% carbohydrate. *P. pardalis* body bone flour has 4% water content, 37% ash, 37% protein, 19% fat, and 3% carbohydrate. The results of the proximate analysis of P. *pardalis* bone flour has not met the national standards of fish flour SNI 2013 for quality I, II, and III. This is because the characteristics of flour and the nutritional content of flour do not meet the SNI limits.

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